TECHNICAL APPENDIX

Seattle, a Climate of Change: Meeting the Kyoto Challenge

Mayor Nickels' Green Ribbon Commission
On Climate Protection

TECHNICAL APPENDIX
March 2006

Recommendations	Tons GHG Reduction
Reduce Seattle's Dependence on Cars	170,000 tons
1. Significantly Increase the Supply of Frequent, Reliable and Convenient PublicTransportation	
2. Significantly Expand Bicycling and Pedestrian Infrastructure	
3. Lead a Regional Partnership to Develop and Implement a Road Pricing System	
4. Implement a New Commercial Parking Tax	
5. Expand Efforts to Create Compact, Green, Urban Neighborhoods	
Increase Fuel Efficiency and Use of Biofuels	200,600 tons
6. Improve the Average Fuel Efficiency of Seattle's Cars and Trucks	
7. Substantially Increase the Use of Biofuels	
8. Significantly Reduce Emissions from Diesel Trucks, Trains and Ships	
Achieve More Efficient and Cleaner Energy for Our Homes and Businesses	316,000 tons
9. Maintain City Light at Zero Net Greenhouse Gas Emissions. Meet Load Growth Through Conservation and Renewable Energy Resources	
10. Substantially Increase Natural Gas Energy Conservation	
11. Strengthen the State Energy Code	
12. Reduce Seattle Steam's Use of Natural Gas	
Build on Seattle's Leadership	Policy Action
13. Continue City of Seattle's Strong Leadership Example	
14. Mobilize the Entire Community	
15. Create the Seattle Climate Partnership	
16. Leverage Regional and State Action for Climate Solutions	
Sustain Our Commitment	Policy Action
17. Direct More Resources to the Challenge	
18. Monitor and Report on Progress	
Subtotal	686,600 tons
Actions Already Underway	
Clean Car Standards	25,000 tons
Appliance Efficiency Standards	9,500 tons
Total	**721,100 tons**
Target: 7 Percent Below 1990 Levels By 2012	**680,000 tons**

DATA, ASSUMPTIONS AND CONVERSIONS USED THROUGHOUT:

- 19.37 pounds CO2 per gallon gasoline (US EPA), "Cp"
- 22.23 pounds CO2 per gallon diesel (US EPA)
- 2204.6 pounds per metric ton
- 1,535,832 metric tons of gasoline-related greenhouse gas emissions projected for 2012 in Seattle, "Tg"
    - 11,174,494 vehicle miles traveled (VMT) per day in 2012 (Puget Sound Regional Council Travel Demand Model run, December 2005).
    - Gasoline vehicles: The average fuel efficiency of all the light duty vehicles on the road in 2010 is assumed to be 21 mpg—only a 10% improvement over 1990 ("m_1").
        - There hasn't been any improvement in the federal fleet fuel economy (CAFE) standards for many years. The new state Clean Car Standards will not take effect until 2009 and are then phased in only gradually.
        - In 2002 (the most recent year data are available) the fuel efficiency of the average passenger car on the road was 22.2 mpg. More than 50% of gasoline vehicles were light duty trucks, minivans and SUVs vehicles and their average fuel efficiency was 20.5 mpg.
        - Consumers in our region replace their cars less frequently than the national average, so dramatic improvements in fleet mpg by 2012 were not assumed.
    - Diesel vehicles: The average fuel efficiency is assumed to increase to 7.5 mpg, about a 15% increase over 1990. According to the U.S. Department of Energy's Transportation Energy Data Book, the average improvement in fuel economy for heavy trucks in just ten years (1992 through 2002) was 13%, and that was in a period of relatively stable fuel prices. However, according to engineers at the Puget Sound Clean Air Agency, most of this improvement comes from the trucking industry phasing out gasoline engines during the 1990s and converting to more fuel efficient diesel engines. Since that fleet turn over is nearly complete, the rate of improved fuel efficiency is likely to be much slower over the next several years.
    - Washington State Department of Transportation is projecting a significant increase in diesel use. In 1990, 14% of all fuel use in the state was diesel, but in 2010, it's projected to grow to 23% of total fuel use.

RECOMMENDATIONS:

REDUCE DEPENDENCE ON CARS
GHG emissions cut by 170,000 metric tons

1. Significantly increase the supply of frequent, reliable, and convenient public transportation

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2. Significantly expand bicycle and pedestrian infrastructure

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3. Lead a regional partnership to develop and implement a road pricing system

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4. Implement a new commercial parking tax

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5. Continue and expand efforts to create compact, green, urban neighborhoods and business districts

Based on a concurrent modeling analysis of Recommendations #1-5 by Mirai Transportation and Planning, Seattle, WA, for Seattle Department of Transportation. The SDOT travel demand model network was updated with appropriate highway, transit, and parking changes from 2000 to create a 2012 baseline.

The Seattle Transit Plan network closely resembled the 2012 baseline; an approximate 5 percent increase in transit service replicated the increase frequencies associated with the plan (e.g., Aurora, 15th West Seattle and MLK corridors and 45th, South Seattle, 80th and Northgate Way).

The 2012 bicycle and pedestrian network was modified to include walk and bike access on all links within the City.

The impact of the new commercial parking tax was analyzed by modeling both a10% and 50% increase of baseline 2012 parking costs for Seattle zones that had an assumed parking cost in 2012; each of these scenarios was run with all other actions. The average of both scenario results was used. A parking tax is assumed to be passed on to the consumer and, therefore, raise the cost of parking

Highway tolls of 13 cents per mile were assumed during peak traffic congestion periods and 4 cents per mile were assumed for off-peak. These rates are consistent with rates assumed for tolling analyses done by WSDOT (reports accessible at www.wsdot.wa.gov/projects/tolls).

Tolls were assumed onI-5 (Everett to Tacoma), I-405, I-90 (Seattle to Issaquah), SR-99 (Greenlake to Spokane St.), and SR-520 (Seattle to Redmond).

According to Seattle Transportation Department staff, total emissions reductions for Recommendations #5 through 9 (modeled as a package to prevent double-counting and to account for synergistic effects) may actually be greater. This is because the transportation models used in this analysis are less sensitive to some of the measures tested such as improved transit reliability and bicycle and pedestrian improvements. Also, associated changes in land use patterns were not accounted for due to lack of data.

INCREASE FUEL EFFICIENCY AND USE OF BIOFUELS
GHG emissions cut by 200,600 metric tons

6. Improve average fuel efficiency of Seattle's cars and trucks

1) Public education on proper tire pressure. (Projected emissions reduction: 4,416 metric tons)

   Data:
   - 174,800,993 gallons gasoline used per year in 2012
   - 3,670,820,845 miles driven in Seattle using gasoline by 2012, "Mg"

   Assumptions:

   - 30% of the fleet has under inflated tires (California Energy Commission and California Air Resources Board. *Reducing California's Petroleum Dependence: A joint Agency Report*, August 2003, Appendix C. More than ¼ of all passenger cars and nearly 1/3 of all light trucks and SUVs).
   - 30% of those who have under inflated tires will take action to inflate them as a result of an aggressive education campaign, "%A"
   - 3.3% efficiency gained by inflating tires to their proper pressure (US EPA, www.fueleconomy.gov), "%E)

   CO2 reduction potential = miles driven by % under inflated fleet that would inflate tires and get 3% efficiency - miles driven by that fleet at 21 mpg

   $(((Mg \times (\%U \times \%A))/ m_1) – (Mg \times (\%U \times \%A)/(m_1 \times \%E + m_1)) \times Cp / 2204.6 =$ 4,416 metric tons CO2 reduction

2) Reduce deadheading (Projected emissions reduction: 5,768 metric tons)

   Data:
   - 600,000 deadhead airport trips/year (Craig Leisy, Supervisor of Consumer Affairs Unit, City of Seattle Department of Executive Administration, personal communication), "Td"

Assumptions:

- 13 miles from downtown to SeaTac is representative of all airport deadhead trips (conservative since trips are frequently much further), "D"
- 12 mpg taxi cab fuel efficiency (conservative because the standard taxicab, the Ford Crown Victoria, gets approximately 11 mpg (City of Seattle Fleets and Facilities), "m_1"

(((Td x D)/ m_1) x Cp)/2204.6 = 5,768 metric tons CO2 reduction

3) Converting taxis to hybrids (9,159 metric tons)

Data:

- 55 mpg for Toyota Prius (EPA combined highway and city rating)

Assumptions:

- 80,000 miles/year for average taxi use (conservative, as probably over 100,000 miles, (Craig Leisy, Supervisor of Consumer Affairs Unit, City of Seattle Department of Executive Administration, personal communication), "D"
- 12 mpg taxi cab fuel efficiency (conservative because the standard taxicab, the Ford Crown Victoria, gets approximately 11 mpg (City of Seattle Fleets and Facilities), "m_1"
- 200 taxis (of over 600) converted, "T_{200}"

CO2 reduction potential = emissions of usual fleet – emissions of hybrid fleet, or

(((D / m_1) x Cp)/2204.6) – (D / m_2) x Cp)/2204.6) x T_{200} = 9159 metric tons CO2 reduction

4) Increase car-sharing through technical assistance, outreach and incentives (900 metric tons)

Assumption:

- Supporting Flexcar and Zipcar helps yield 2 million pounds of reductions given a 1.5% market penetration rate (per Flexcar's analysis using the market penetration rate of Switzerland).

2,000,000 pounds / 2204.6 = 907 metric tons CO2 reduction

5) Lead a regional partnership and fuel efficiency education and awareness campaign (15,350 metric tons)

Assumption:

- A fuel efficiency and outreach campaign would reduce fuel consumption by at least 1% of gasoline use

Tg x 1% = 15,350 metric tons CO2 reduction

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7. Substantially increase the use of biofuels

1) Biodiesel (132,002 metric tons)
   Data:
   - 548,364 metric tons on road diesel emissions projected for 2012 in Seattle, "TRd"
   - 565,600 metric tons non road diesel emissions projected for 2012 in Seattle, "TNr"

   Assumptions:

   - 58% of non-road diesel use is capable of converting to B20 by 2012, "%Nr"
     - We estimate that 90% of non-road diesel unrelated to marine vessels (construction equipment, trains) could convert to B20 by 2012 (per Mark Brady, Puget Sound Clean Cities Coalition Program Manager)
     - We estimate that 25% of marine vessel use could convert to B20 by 2012. (We recognize difficultly in transitioning ocean-going vessels to B20 in the near-term; marine conversions that are likely include Washington State Ferry System, pleasure boats, small tugs, etc.).
       - To determine a weighted average for the marine non-road and other non-road, we determined that 50.28% of Puget Sound's non road use is from marine vessels (in 1990; lower for 2000 so therefore conservative); we assume the same % mix of Seattle's non road use
   - %, According to the US Department of Energy and US Department of Agriculture, biodiesel produces 78% less CO2 than petroleum diesel, May 1998, *Life Cycle Inventory of Biodiesel and Petroleum Diesel for Use in an Urban Bus* and referenced by Seattle City Light.
   - 95% of on road diesel use is capable of converting to B20 by 2012, "%Rd"
   - Statewide production capability (estimated at 100,000,000 gallons) is far beyond Seattle consumption of on and non road diesel (in total, ~22,000,000 gallons)

   CO2 reduction potential = (Total road diesel emissions – converted biodiesel emissions) + (Total non road diesel emissions – converted biodiesel emissions), or

   (((TRd*%Rd)-(TRd*%Rd*0.8)-(TRd*%Rd*0.2*(1-.78))) + (((TNr*%Nr)-(TNr*%Nr*0.8)-(TNr*%Nr*0.2*(1-.78)) = 132,002 metric tons CO2 reduction

2) Ethanol (33,558 metric tons)

   Data:
   - 11,174,494 vehicle miles traveled per day in Seattle in 2012(PSRC Travel Demand Model)
   - 174,801,013 gallons of gasoline consumption/year in Seattle in 2012 ((1,535,832 metric tons from GHG inventory x 2204.6)/22.23), "Gy"

   Assumptions:

   - 95% of gasoline vehicles will use E10 in Seattle by 2012, based on the trend in the industry, the high percentage of Washington state gasoline that already includes ethanol (or is E10), and new state legislation that mandates that biofuels will be incorporated into Washington State's fuel supply starting in 2008.
   - 2.30% less emissions from E10 than gasoline (corn based, assuming dry milling instead of wet milling and according to Wang 2005: http://www.ethanol-gec.org/netenergy/UpdateEnergyGreenhouse.pdf. (Cellulosic ethanol has far

greater—up to 3 times—the GHG benefits but was not used in this 33,558 metric ton estimate.)

CO2 reduction potential = Total gas emissions – converted ethanol emissions

(Gy*Cp/2204.6)-(Gy*Cp/2204.6*(1-95%)+(((Gy*95%)*Cp/2204.6)-((Gy*95%)*Cp/2204.6*2.3%))) = 33,558 metric tons CO2 reduction

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8. Significantly reduce diesel emissions from diesel trucks, trains and ships

While we did not estimate GHG reductions for this category (and there may be overlap with the GHG reductions of other recommendations), below is an example of potential reductions of one aspect of this recommendation for illustrative purposes.

Cruise ships

Data:

- In 2005, City Light provided a connection at Terminal 30 which allowed Princess Cruiselines to convert to electricity while at port for "hotelling" (i.e., to run all electrical systems.) Prior to converting, the cruise ship used 8,239 gallons of diesel per day in port. (Cruise ships vary in size, engine types and days in port, but the CO2 reductions at Terminal 30 from the Princess Cruise Ship provide a reasonable example of the level of reductions that can be achieved by connecting cruise ships to shorepower.)
- Days in port: 39

8239 x 39 x 22.23 / 2204.6 = 3,240 metric tons CO2 reduction per year per ship

Assumptions: Other cruise ships' engines range in their fuel consumption per hour, therefore, CO2 reductions vary from between 2,300 and 4,000 metric tons

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ACHIEVE MORE EFFICIENT AND CLEANER ENERGY FOR OUR HOMES AND BUSINESSES

GHG emissions cut by 316,000 metric tons

9. Maintain City Light at zero net GHG emissions. Meet load growth through conservation and renewable energy resources

Data: Per a memo sent by Lynn Best, Environmental Affairs Director Seattle City Light, to Kim Drury, OSE, October 2005:

City Light is committed to zero net greenhouse gas emissions which was achieved for the first time in 2005. Assuming the utility and the City maintain the commitment to zero net greenhouse gas emissions, it results in zero projected City Light emissions for 2012.

City Light estimates that, based on its current energy resource mix, its GHG emissions in 2012 would be approximately 200,000 metric tons - if it took no further action to reduce or mitigate those emissions. However, the utility will do a combination of new conservation and renewables to meet its load growth - the amount and timing to be informed by its IRP. City Light invests in conservation as an energy resource, which has the effect of substantially reducing the utility's GHG emissions. Whatever net GHG emissions are left after conservation and renewable acquisition will be mitigated through offsets.

In 2005, City Light acquired approximately 6 aMW of conservation savings to meet its resource needs. Each aMW acquired also avoids about 4,774 metric tons of CO2 at a levelized cost of approximately $40 per ton of CO2 avoided.

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10. Substantially increase natural gas energy conservation

Data:
Based on data supplied by Puget Sound Energy (PSE) as part of its integrated resource plan. Seattle specific data provided by Quantec, Inc, for OSE. Both technical and achievable cumulative residential and commercial natural gas conservation projections for Seattle from 2006-2012 were calculated. (Industrial conservation estimates are not included in this amount, but only account for approximately 3% of conservation potential in similar models for the same period.) "Achievable conservation" refers to the estimated amount of conservation that can be achieved through a conservation program consisting of financial incentives that are cost effective to the utility, technical assistance and marketing. The difference between achievable and technical conservation potential is generally to account for market realities, e.g., not every building owner will want to install a particular energy conservation measure no matter how cost effective, nor do all buildings and energy uses lend themselves to optimal energy efficiency retrofits.

Technical conservation potential = 2.1 million decatherms or 105,000 metric tons of avoided CO2
Achievable potential = 551,104 decatherms of CO2 or 27,000 metric tons of avoided CO2

We used the average of the two— 66,000 metric tons

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11. Strengthen state residential energy code
No estimate

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12. Reduce Seattle Steam's use of natural gas

Based on an analysis by Seattle Steam submitted to Seattle City Light in September 2005 "Seattle Steam Company Urban Wood Biomass Boiler Project"—50,000 metric tons.

SUSTAIN AND BUILD ON SEATTLE'S LEADERSHIP
Policy Action: No estimate

13. Continue City of Seattle's strong leadership example

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14. Mobilize the entire community

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15. Create the Seattle Climate Partnership

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16. Leverage regional and state action for climate solutions

SUSTAIN OUR COMMITMENT
Policy Action: No direct CO2 emissions reductions

17. Direct more resources to the challenge

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18. Monitor and report on progress

ACTIONS ALREADY UNDERWAY
GHG emissions cut by 34,500 metric tons

1) 2005 clean car standards (25,000 metric tons)

Data:

- 180,000 metric metric tons saved in King, Kitsap, Pierce, and Snohomish Counties for implementation of WA State Clean Car Bill by 2012 (Puget Sound Clean Air Agency)
- 14% Puget Sound VMT is from Seattle (based on most recent PSRC regional VMT data of 80,000,000 miles/day and the Seattle VMT of 11,174,494 miles/day)

180,000 x 14% = 25,143 metric tons CO2 reduction

2) Appliance efficiency standards (9,500 metric tons)

Data:

Total first year statewide savings, therms, 1,909,000. Source: "State Appliance and Equipment Energy Efficiency Standards", Washington Dept of Community Trade and Economic Development Energy Policy, Liz Klumpp. Appliances included:

commercial pre-rinse spray valves; commercial clothes washers; commercial natural gas unit heaters.

Assumptions:

- 20% of statewide commercial gas use is in Seattle. Percentage assumption is based on 2004 PSE total commercial gas use in Seattle vs US DOE Energy Information Data base for 2004 Washington State total commercial natural gas use.
- Avoided GHG emissions are cumulative from 2007 through 2012 (five years.)
- 1 therm = 11 lbs of CO2
- (20% X 1,909,000) X 11lbs X 5 yrs ÷ 2205 = 9523 metric tons CO2 reduction